

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (Original) An ink jet printing head, comprising:
 - a base;
 - a nozzle plate defining a plurality of nozzle apertures;
 - an array of piezoelectric elements, said piezoelectric elements being arranged at predetermined intervals;
 - wherein each of said piezoelectric elements has one surface that is fixed onto said base and another surface which confronts a respective one of the nozzle apertures of said nozzle plate;
 - wherein said piezoelectric elements are formed by alternately stacking piezoelectric material and conductive material to form a lamination having multiple piezoelectric layers and multiple conductive layers, burning the lamination of said piezoelectric material layers and said conductive material layers to provide a piezoelectric plate, and cutting said piezoelectric plate into a plurality of piezoelectric elements with a predetermined width so that a lamination direction coincides with a main vibrating direction;
 - wherein the main vibrating direction is a direction extending between the one surface and the other surface through each of said piezoelectric elements;
 - wherein gaps for storing ink are respectively provided between the other surfaces of said piezoelectric elements and the respective ones of the nozzle apertures of said nozzle plate;

wherein said piezoelectric elements include a row of said piezoelectric elements alternating between first piezoelectric elements and second piezoelectric elements; and

wherein, of said piezoelectric elements, only said first piezoelectric elements are configured to produce an ink jetting force in accordance with print signals supplied to the ink jet printing head.

2. (Original) The ink jet printing head according to claim 1, wherein said second piezoelectric elements form structural supports extending a predetermined distance between said base and said nozzle plate.

3. (Original) The ink jet printing head according to claim 1, wherein each of the ink storage gaps is uniquely associated with one of said first piezoelectric elements and is segregated from adjacent ones of the ink storage gaps by partitions.

4. (Original) The ink jet printing head according to claim 3, wherein said second piezoelectric elements provide said partitions.

5. (Original) The ink jet printing head according to claim 2, wherein said second piezoelectric elements are longer in the lamination direction than said first piezoelectric elements.

6. (Original) The ink jet printing head according to claim 2, wherein said first piezoelectric elements are wider in a direction perpendicular to the lamination direction than said second piezoelectric elements.

7. (Original) An ink jet printing head, comprising:

a base;

a plurality of piezoelectric elements arranged in rows on said base, each row including first piezoelectric elements and second piezoelectric elements alternately arrayed along the row, the first piezoelectric elements being actuatable to apply a compressive force on ink in accordance with print signals, the second piezoelectric elements being fixed and not actuatable by print signals, said first and second piezoelectric elements having a multilayer structure including laminated layers;

a nozzle plate including nozzles located above said respective first piezoelectric elements; and

ink chamber areas, containing ink, located at least respectively between the nozzles and said first piezoelectric elements.

8. (Original) The ink jet printing head according to claim 7, wherein said second piezoelectric elements form structural supports extending a predetermined distance between said base and said nozzle plate.

9. (Original) The ink jet printing head according to claim 7, wherein each of the ink chamber areas is uniquely associated with one of said first piezoelectric elements and is segregated from adjacent ones of the ink chamber areas by partitions.

10. (Original) The ink jet printing head according to claim 9, wherein said second piezoelectric elements provide said partitions.

11. (New) A drop-on-demand ink-jet printing head comprising:
a nozzle plate having an array of a plurality of nozzle apertures;
an array of a plurality of piezoelectric elements arranged at regular intervals and fixed at one end thereof to a base, other ends of said piezoelectric elements, respectively, being free ends which are in opposition to respective ones of said nozzle apertures;
ink reservoir portions disposed between said nozzle apertures and said free ends,
wherein said piezoelectric elements are formed by cutting into divided pieces, at predetermined widths, a piezoelectric plate obtained by a lamination of at least two layers of piezoelectric material and at least two layers of conductive material stacked alternately in layers;
and
a vibration plate being driven by said piezoelectric element array and interposed between said nozzle plate and said piezoelectric element array,
wherein ink droplets are ejected in a same direction as a main vibration direction of said vibration plate.

12. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein said piezoelectric plate is obtained by one of firing and burning a lamination of paste-like piezoelectric material and conductive material stacked alternately in layers.

13. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein said ink reservoirs are formed by providing recess portions in a spacer interposed between said nozzle plate and said vibration plate.

14. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein said ink reservoirs are formed by providing recess portions in one of said nozzle plate and said vibration plate.

15. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein elastic material is injected between adjacent piezoelectric elements.

16. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein recess portions are formed at said nozzle apertures opposite to said free ends of respective piezoelectric elements.

17. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein each of said piezoelectric elements has an immovable area at a base side.

18. (New) The drop-on-demand ink-jet printing head according to claim 17, wherein said immovable area has a length equal to a quarter of a vibration wavelength of said piezoelectric element.

19. (New) The drop-on-demand ink-jet printing head according to claim 11, further comprising a viscoelastic material layer interposed between said piezoelectric elements and said base so as to fix said piezoelectric elements to said base.

20. (New) The drop-on-demand ink-jet printing head according to claim 11, further including slits which are formed in said piezoelectric elements at a base side thereof.

21. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein said nozzle plate is supported by a support member so as to be disposed in opposition to said free ends of said piezoelectric elements with a predetermined space therebetween.

22. (New) The drop-on-demand ink-jet printing head according to claim 21, wherein said support member comprises a piezoelectric element plate.

23. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein a direction of the cutting is disposed by a predetermined angle from a direction perpendicular to a direction of said array of said nozzle apertures.

24. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein said piezoelectric material and said conductive material are laminated in parallel to said piezoelectric plate.

25. (New) The drop-on-demand ink-jet printing head according to claim 11, wherein said piezoelectric material and said conductive material are laminated perpendicular to said piezoelectric plate.

26. (New) The drop-on-demand ink-jet printing head according to claim 11, further including support members which are disposed on both sides of respective piezoelectric elements.

27. (New) A drop-on-demand ink-jet printing head, comprising:
a nozzle plate having an array of a plurality of nozzle apertures;
an array of a plurality of piezoelectric elements arranged at regular intervals and fixed at one end thereof to a base, other ends of said piezoelectric elements, respectively, being free ends which are in opposition to respective ones of said nozzle apertures;
ink reservoir portions disposed between said nozzle apertures and said free ends,
wherein said piezoelectric elements are formed by cutting into divided pieces, at predetermined widths, a piezoelectric plate obtained by a lamination of at least two layers of piezoelectric material and at least two layers of conductive material stacked alternately in layers;
and

a vibration plate interposed between said nozzle plate and said piezoelectric element array, said vibration plate having concave portions in a vicinity of portions where said vibration plate contacts said piezoelectric elements, said vibration plate being driven by said piezoelectric element array,

whereby ink droplets are ejected in a same direction as a main vibration direction of said vibration plate.

28. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein the said piezoelectric plate is obtained by one of firing and burning a lamination of paste-like piezoelectric material and conductive material stacked alternately in layers.

29. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein said ink reservoirs are formed by providing recess portions in a spacer interposed between said nozzle plate and said vibration plate.

30. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein said ink reservoirs are formed by providing recess portions in one of said nozzle plate and said vibration plate.

31. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein elastic material is injected between adjacent piezoelectric elements.

32. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein recess portions are formed at said nozzle apertures opposite to said free ends of respective piezoelectric elements.

33. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein each of said piezoelectric elements has an immovable area at a base side.

34. (New) The drop-on-demand ink-jet printing head according to claim 33, wherein said immovable area has a length equal to a quarter of a vibration wavelength of said piezoelectric element.

35. (New) The drop-on-demand ink-jet printing head according to claim 27, further comprising a viscoelastic material layer interposed between said piezoelectric elements and said base so as to fix said piezoelectric elements to said base.

36. (New) The drop-on-demand ink-jet printing head according to claim 27, further including slits which are formed in said piezoelectric elements at a base side thereof.

37. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein said nozzle plate is supported by a support member so as to be disposed in opposition to said free ends of said piezoelectric elements with a predetermined space therebetween.

38. (New) The drop-on-demand ink-jet printing head according to claim 37, wherein said support member comprises a piezoelectric element plate.

39. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein a direction of the cutting is disposed by a predetermined angle from a direction perpendicular to a direction of said array of said nozzle apertures.

40. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein said piezoelectric material and said conductive material are laminated in parallel to said piezoelectric plate.

41. (New) The drop-on-demand ink-jet printing head according to claim 27, wherein said piezoelectric material and said conductive material are laminated perpendicular to said piezoelectric plate.

42. (New) The drop-on-demand ink-jet printing head according to claim 27, further including support members which are disposed on both sides of respective piezoelectric elements.

43. (New) A drop-on-demand ink-jet printing head, comprising:

a nozzle plate having an array of a plurality of nozzle apertures;

an array of a plurality of piezoelectric elements arranged at regular intervals and fixed at one end thereof to a base, other ends of said piezoelectric elements, respectively, being free ends which are in opposition to respective ones of said nozzle apertures;

ink reservoir portions being formed between said nozzle apertures and said free ends;

wherein said piezoelectric elements are formed by cutting into divided pieces, at predetermined widths, a piezoelectric plate arranged on said base parallel therewith, said piezoelectric plate being obtained by a lamination of at least two layers of piezoelectric material and at least two layers of conductive material stacked alternately in layers; and

a vibration plate which is driven by said piezoelectric element array and interposed between said nozzle plate and said piezoelectric element array, whereby ink droplets are ejected in a same direction as a main vibration direction of said vibration plate.

44. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein said piezoelectric plate is obtained by one of firing and burning a lamination of paste-like piezoelectric material and conductive material stacked alternately in layers.

45. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein said ink reservoirs are formed by providing recess portions in a spacer interposed between said nozzle plate and said vibration plate.

46. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein said ink reservoirs are formed by providing recess portions in one of said nozzle plate and said vibration plate.

47. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein elastic material is injected between adjacent piezoelectric elements.

48. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein recess portions are formed at said nozzle apertures opposite to said free ends of respective piezoelectric elements.

49. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein each of said piezoelectric elements has an immovable area at a base side.

50. (New) The drop-on-demand ink-jet printing head according to claim 49, wherein said immovable area has a length equal to a quarter of a vibration wavelength of said piezoelectric element.

51. (New) The drop-on-demand ink-jet printing head according to claim 43, further comprising a viscoelastic material layer interposed between said piezoelectric elements and said base so as to fix said piezoelectric elements to said base.

52. (New) The drop-on-demand ink-jet printing head according to claim 43, further including slits which are formed in said piezoelectric elements at a base side thereof.

53. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein said nozzle plate is supported by a support member so as to be disposed in opposition to said free ends of said piezoelectric elements with a predetermined space therebetween.

54. (New) The drop-on-demand ink-jet printing head according to claim 53, wherein said support member comprises a piezoelectric element plate.

55. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein a direction of the cutting is disposed by a predetermined angle from a direction perpendicular to a direction of said array of said nozzle apertures.

56. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein said piezoelectric material and said conductive material are laminated in parallel to said piezoelectric plate.

57. (New) The drop-on-demand ink-jet printing head according to claim 43, wherein said piezoelectric material and said conductive material are laminated perpendicular to said piezoelectric plate.

58. (New) The drop-on-demand ink-jet printing head according to claim 43, in which support members are disposed on both sides of respective piezoelectric elements.